KAJIAN BIOPENGESAN POLIANILINA BESERTA PENCIRIANNYA

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Abstrak: Beberapa kajian melaporkan keburukan pengesan (kimia dan elektrokimia) berasaskan polimer konduksi menggunakan kaedah swa-atur monolapisan dan pengenapan filem LB dalam proses pembuatannya. Contohnya, kaedah penjerapan fizikal adalah cenderung untuk bergumpal dan mempamerkan ketidakstabilan di mana ikatan kovalen menyebabkan pengurangan dalam aktiviti biomolekul. Selain itu, kaedah ini tidak menyediakan kawalan terhadap bilangan enzim yang dipegunkan. Oleh itu, persepsi terhadap kaedah pembuatan biopengesan menggunakan kaedah ini perlu dijelaskan supaya tidak wujud keterhadan dalam proses fabrikasi biopengesan. Buku ini memberikan panduan serta perkongsian mengenai biopengesan dan perkara yang berkaitan dengannya.

Kata kunci: polimer konduksi, fabrikasi biopengesan, aktiviti biomolekul

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Senarai Kandungan

Prakata

Beberapa kajian melaporkan keburukan pengesan (kimia dan elektrokimia) berasaskan polimer konduksi menggunakan kaedah swa-atur monolapisan dan pengenapan filem LB dalam proses pembuatannya. Contohnya, kaedah penjerapan fizikal adalah cenderung untuk bergumpal dan mempamerkan ketidakstabilan di mana ikatan kovalen menyebabkan pengurangan dalam aktiviti biomolekul. Selain itu, kaedah ini tidak menyediakan kawalan terhadap bilangan enzim yang dipegunkan. Oleh itu, persepsi terhadap kaedah pembuatan biopengesan menggunakan kaedah ini perlu dijelaskan supaya tidak wujud keterhadan dalam proses fabrikasi biopengesan. Buku ini memberikan panduan serta perkongsian mengenai biopengesan dan perkara yang berkaitan dengannya.

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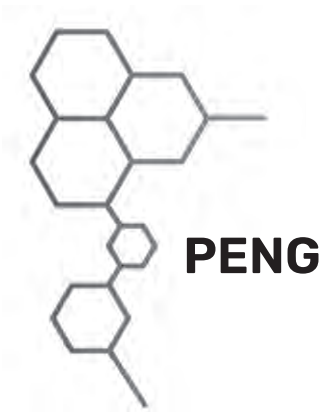

1

PENGENALAN

1.1 ELEKTROENAPAN

Elektroenapan adalah proses di mana arus elektrik digunakan untuk proses pengenapan bahan ke atas substrat. Tujuan elektroenapan dilakukan adalah untuk menambah sifat-sifat yang dikehendaki yang tiada pada bahan seperti tahan kakisan dan haus, perlindungan dari karat, pelinciran, kualiti estetik dan lain-lain. Sampel yang akan dienapkan bahan ke atasnya akan menjadi katod manakala anod pula adalah bahan yang ingin dienapkan (Toko 2000). Kedua-dua komponen direndam dalam larutan yang dikenali sebagai elektrolit mengandungi satu atau lebih garam logam terlarut dan juga ion lain yang membenarkan pengaliran elektrik.

Walther (2006) mendefinisikan bahawa kaedah elektroenapan adalah kaedah yang menggunakan arus elektrik untuk menurunkan kation bahan yang dikehendaki daripada larutan dan menyelaputi objek konduksi dengan lapisan nipis seperti logam. Proses ini digunakan untuk mengenapkan lapisan bahan bagi memberikan sifat atau ciri yang diingini seperti tahan kakisan dan haus, perlindungan dari karat dan pelinciran kepada permukaan dengan kata lain meningkatkan sifat tersebut.

2

ULASAN KAJIAN TERDAHULU

2.1 PENGENAPAN LAPISAN POLIMER KE ATAS PERMUKAAN SUBSTRAT

2.1.1 Kaedah Palung Langmuir-Blodgett (LB)

Monolapisan dibentuk pada permukaan subfasa dengan melarutkan bahan amfifilik dalam pelarut yang sesuai dan menyebarkan titisan larutan tersebut pada permukaan air. Penyebaran larutan dilakukan dengan membenarkan titisan kecil bahan jatuh daripada penyuntik yang berada beberapa milimeter di atas subfasa (Roberts 1990). Larutan titisan tadi dibiarkan menyejat sebelum kaedah berikutnya dilakukan. Penyebaran larutan titisan bagi membentuk filem dilakukan dengan sama rata di keseluruhan permukaan subfasa. Penyebaran secara semulajadi akan berterusan sehingga tekanan permukaan monolapisan sama dengan keseimbangan tekanan penyebaran. Pada titik ini, semua permukaan diliputi oleh monolapisan dan sebarang titisan larutan selanjutnya kekal berada dalam monolapisan sebagai lapisan apungan, apabila tiada lagi penyebaran mengambil tempat. Sebarang bahan yang tidak tersebar mestilah dipindahkan atau ia mungkin terenap sebagai gumpalan pada substrat.

3

BAHAN DAN KAEDAH

3.1 BAHAN KIMIA

Terdapat tiga jenis polimer yang digunakan dalam kajian ini iaitu polianilina emeraldina bes (PANI) dengan jisim molekul 10,000 dan nombor produk: 476706 (10g). Ia bersifat higroskopik dan dalam keadaan serbuk berwarna biru tua. Kedua, polipirol (PPY) dengan nombor produk: 577030 (5g). Kekonduksiannya sekitar 10- 40 Scm^{-1} dan dalam keadaan serbuk berwarna hitam. Ketiga, poli (tiofena-3-[2-(2- methoxyethoxy) ethoxy]-2 isopropanol dengan nombor produk: 699799 (25ml). Ia disimpan pada suhu 2-8 ^{o}C dan berada dalam keadaan cecair berwarna biru terang serta peka pada cahaya. Ketiga-tiga jenis polimer ini adalah polimer konduksi yang dibeli dari Sigma-Aldrich, bersifat merengsa dan digunakan hanya untuk kerja- kerja penyelidikan (R&D) sahaja.

Metanol (CH_3OH) dengan jisim molar 32.04 $gmol^{-1}$ serta ketumpatan: 0.7918 gcm^{-3} telah dibeli dari Merck. Metanol bertindak sebagai pelarut untuk PANI, PPY dan PT. Etanol (C_2H_5OH) dengan jisim molar 46.068 $gmol^{-1}$ serta ketumpatan: 0.789 gcm^{-3}, ~95% v/v min telah dibeli dari bahan kimia R&M. Aseton (CH_3COCH_3) dengan jisim molar 58.08 $gmol^{-1}$ serta ketumpatan: 0.7925gcm^{-3} telah dibeli dari Merck. Etanol dan aseton digunakan dalam proses

4

PEMBENTUKAN MONOLAPISAN POLIANILINA

4.1 KEPUTUSAN DAN PERBINCANGAN

4.1.1 Keterlarutan PANI dalam Pelarut Alkohol

PANI adalah sejenis polimer yang tidak larut dalam kebanyakan pelarut organik. Masalah ini dapat diatasi dengan menggantikan salah satu hidrogennya dengan kumpulan alkil, alkosi, aril hidroksil, amino atau halogen pada rantai nukleus anilina. Pelarut metanol digunakan kerana melalui kajian yang dilakukan oleh Tan & Blackwood (2000) melaporkan wujud ikatan hidrogen yang kuat di antara molekul PANI dan metanol apabila PANI dilarutkan ke dalam metanol. Ikatan tersebut terhasil melalui tindakbalas daripada salah satu pasangan tunggal atom oksigen metanol yang bergabung dengan ikatan hidrogen PANI (Rajah 4.1). Ini secara tidak langsung menolak rantai polimer dan menyebabkan rantai alkil yang panjang terbentuk (Al- Ghamdi & Al-Saigh 2002).

5

PROSES PENGENAPAN LAPIS DEMI LAPIS PT/ PPY/ PANI

5.1 KEPUTUSAN DAN PERBINCANGAN

5.1.1 Keterlarutan PPY dan PT dalam Pelarut Alkohol

Sebelum memulakan proses pencelupan ke atas PPY dan PT, penghasilan larutan celupan dilakukan terlebih dahulu. Kedua-dua jenis polimer tersebut dilarutkan dalam metanol yang bertindak sebagai pelarut. Ini bagi memberikan kadar keterlarutan yang sama seperti yang dilakukan kepada PANI. Keterlarutan polimer dalam sesebuah pelarut adalah sukar disebabkan ikatan rantainya yang kuat. Hartel et al. (2005) menjelaskan bahawa pelarut seperti asid hidroklorik (HCl) juga boleh digunakan untuk melarutkan polimer tetapi jika kepekatan HCl yang digunakan adalah tinggi, ia akan mempengaruhi morfologi zarah yang terbentuk. Ini terjadi disebabkan oleh kesan yang diberikan oleh kumpulan alkil polimer.

Rajah 5.1 menunjukkan spektrum UV-Vis. PPY dalam dan tanpa metanol. Metanol tidak menunjukkan sebarang puncak disebabkan kadar penyerapannya yang lemah pada sesetengah panjang gelombang. Metanol adalah pelarut organik. Pelarut organik mempunyai kadar penyerapan yang tertentu dan tidak semua pelarut sesuai digunakan

6

ELEKTROENAPAN ENZIM HRP KE ATASSUBSTRAT LAPIS PT/ PPY/ PANI DI ATAS KACA ITO

6.1 KEPUTUSAN DAN PERBINCANGAN

6.1.1 Hubungan di antara PANI, PPY, PT dan HRP

Sebelum melakukan proses elektroenapan, ujikaji dimulakan terlebih dahulu dengan melihat kesan dan hubungan setiap polimer (PANI, PPY, PT) terhadap HRP. Ini dilakukan untuk melihat tindakbalas dan kesan yang berlaku. Sampel disediakan dengan mengikut kaedah penyediaan sebelum ini di mana PANI menggunakan teknik Langmuir-Blodgett (LB). Manakala enapan lapisan PPY dan PT menggunakan teknik lapis demi lapis (LBL). Rajah 6.1, 6.2 dan 6.3 mempamerkan spektrum UV-Vis. PANI, PPY dan PT dengan HRP. Persamaan di antara ketiga-tiga rajah adalah peningkatan dalam kadar penyerapan apabila HRP dienapkan ke atas ketiga- tiga polimer. PANI, PPY dan PT adalah keluarga polimer konduksi yang mempunyai keupayaan untuk menyerap sinaran elektromagnet disebabkan kewujudan elektron valensinya yang boleh diujakan ke peringkat yang lebih tinggi.

Bagi Rajah 6.1 didapati wujud dua puncak pada lengkung HRP/PANI iaitu pada panjang gelombang 330 nm dan 720 nm. Puncak tersebut merujuk kepada gangguan rantai

7

BIOPENGESAN H_2O_2

7.1 KEPUTUSAN DAN PERBINCANGAN

7.1.1 Kepekatan H_2O_2

Sebelum melakukan eksperimen yang selanjutnya, kepekatan H_2O_2 telah dipelbagaikan untuk mengkaji kesesuaian kepekatan yang akan digunakan dalam proses pengesanan. Kepelbagaian kepekatan dimulakan daripada 0.1M sehingga ke 1.0M. Spektrum UV-Vis. pada Rajah 7.1 menunjukkan pada kepekatan 0.1M, bacaan penyerapan adalah tinggi. Penyerapan berkaitan dengan spesis yang melakukan penyerapan. Kepekatan H_2O_2 yang tinggi menyebabkan pertambahan pada saiz molekul. Maka pada satu jangka masa tertentu, molekul akan bergumpal sesama sendiri dan membentuk saiz yang lebih besar (Zhou et al. 2007). Berbanding dengan sistem yang mempunyai kepekatan yang rendah, penggumpalan molekul adalah lebih lambat dan molekul yang terhasil adalah lebih kecil.

Penyantaian dan perubahan bentuk rantai terhasil daripada penambahan elektron atau lohong kepada rantaian menyebabkan pelbagai zarah, soliton, polaron dan bipolaron yang mempunyai sifat pembawa yang tersendiri terhasil. Apabila elektron ditambah kepada rantaian ianya

8

RUMUSAN DAN CADANGAN

8.1 RUMUSAN DAN PENEMUAN KAJIAN

Secara kesimpulannya, kesemua objektif yang dinyatakan dalam Bab I telah dicapai. Objektif pertama adalah untuk mengkaji proses yang berlaku semasa pengenapan polielektrolit (PPY dan PT) diikuti enzim (HRP) terhadap monolapisan PANI. Dalam kajian ini, gabungan kaedah seperti kaedah LB, LBL dan elektroenapan telah berjaya menghasilkan lapisan yang sesuai untuk sokongan polimer bagi HRP yang kemudiannya berperanan sebagai pengesan untuk H_2O_2. Proses protonasi, penghasilan polaron, tindakbalas lapis demi lapis, proses pemegunan, proses penurunan dan pengoksidaan, proses pembauran dan proses degradasi permukaan adalah sebahagian proses yang berlaku semasa pengenapan PPY, PT dan HRP ke atas monolapisan PANI. Kajian ini menunjukan sifat kestabilan polimer terdop adalah lebih baik sekiranya dibandingkan dengan polimer tulen. Ini berlaku disebabkan oleh bahan dalam matriks polimer menghasilkan pengikatan yang lebih tinggi yang terhasil daripada interaksi bahan dengan pasangan bebas elektron atom N dalam rantai induk polimer. Saiz dan sifat morfologi bahan pula didapati dipengaruhi oleh jangka masa tindak balas pembentukan. Pencirian menggunakan VPSEM dan AFM mendapati,

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Siti Amira Othman adalah staf di Universiti Tun Hussein Onn Malaysia. Beliau memperolehi ijazah Sarjana Muda dalam bidang sains nuklear dari Universiti Kebangsaan Malaysia dan seterusnya menyambung pengajian Doktor Falsafah dalam bidang sains bahan di universiti yang sama. Minat menulis mula dipupuk apabila terdapat keperluan untuk menerbitkan kertas kajian ilmiah setiap tahun. Ini ditambah dengan hasrat ingin cuba menulis dalam genre yang berbeza seperti artikel am di dalam media massa, buku ilmiah, puisi, buku penyelidikan, bab buku, dan pelbagai lagi bentuk penulisan. Kebanyakan topik kajian yang diterbitkan adalah berkenaan fizik sinaran, keselamatan sinaran mengion dan juga bacaan ringan seperti artikel pendek yang mensasarkan golongan pembaca dalam golongan remaja. Pencapaian melibatkan penulisan adalah apabila berjaya menerbitkan lebih dari 100 bab buku pada tahun 2019.

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Kajian Biopengesan POLIANILINA beserta Penciriannya

Beberapa kajian melaporkan keburukan pengesan (kimia dan elektrokimia) berasaskan polimer konduksi menggunakan kaedah swa-atur monolapisan dan pengenapan filem LB dalam proses pembuatannya. Contohnya, kaedah penjerapan fizikal adalah cenderung untuk bergumpal dan mempamerkan ketidakstabilan di mana ikatan kovalen menyebabkan pengurangan dalam aktiviti biomolekul. Selain itu, kaedah ini tidak menyediakan kawalan terhadap bilangan enzim yang dipegunkan. Oleh itu, persepsi terhadap kaedah pembuatan biopengesan menggunakan kaedah ini perlu dijelaskan supaya tidak wujud keterhadan dalam proses fabrikasi biopengesan. Buku ini memberikan panduan serta perkongsian mengenai biopengesan dan perkara yang berkaitan dengannya.

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